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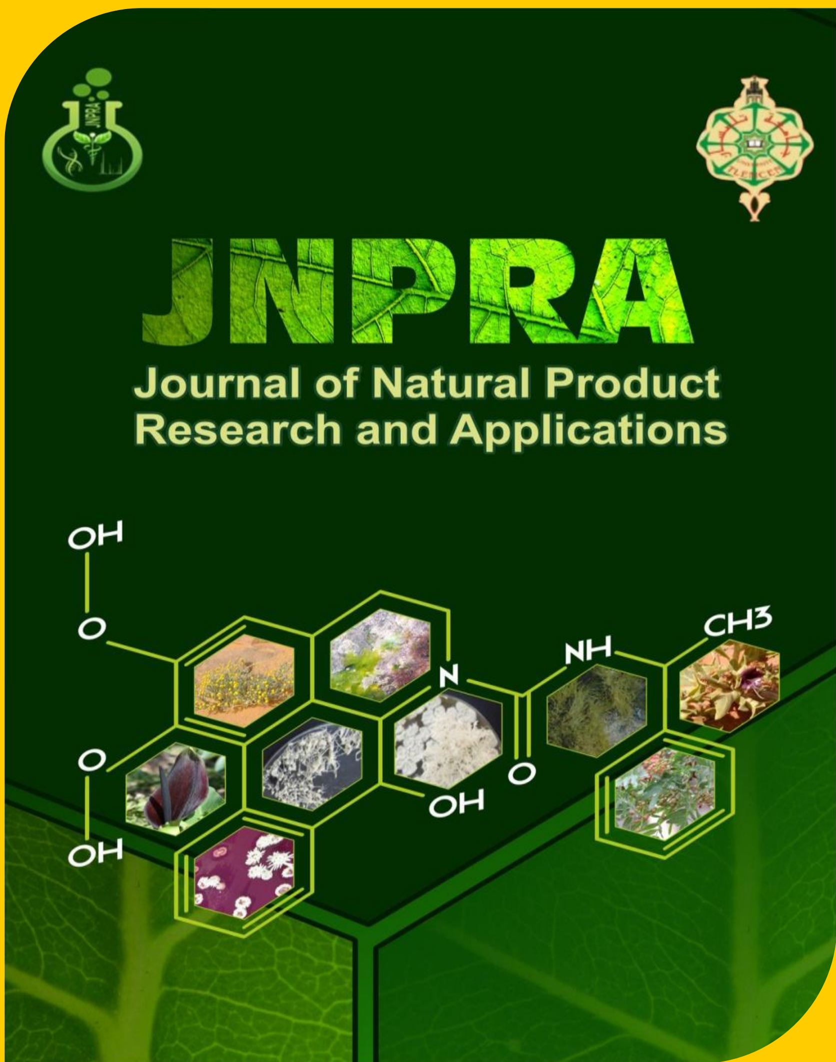

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Physicochemical parameters of oil extracted from *Ricinus communis* L. seeds

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Highlights

- The seeds of Ricinus communis were rich in oil.
- This seed oil has been extensively evaluated.
- Various physicochemical properties of oil have been determined.
- Evaluation of the antioxidant activity of the oil.

Graphical Abstract

Abstract

The objective of our work in this study is the extraction and characterization of castor oil (*Ricinus communis* L) physicochemical characterization for a better appreciation of the oil. Extraction of The castor bean oil is made by the chemical method Soxhlet (extracted with petroleum ether) gave an oil yield of the order of 29.17% and for the results of the physicochemical parameters the values are as follows: Acid value is 0.57mg KOH/g oil, acidity is 0.28%, saponification number is 177.42 mg KOH/g oil, 93.39g/100g Oil for the iodine value and 7.83 meq of active O2 / Kg of oil for the peroxide number, the density being 0.956 at 20°C, the refractive index at 20°C equal to 1.4778 And the rotation angle is 4.20. Finally, a study of the antioxidant activity of the oil was carried out by the method of trapping the free radical DPPH, the results obtained showed the existence of a less important antioxidant activity (IC_{50} = 431.73 µg/ml) for Castor seed oil versus antioxidant references.

Key words: *Ricinus communis* L, Physicochemical characteristics, antioxidant activity.

1. Introduction

For a long time, man has used plants, first for food and then for healing. He gradually learned to recognize edible plants and poisonous plants, using some of them in different uses. This knowledge is transmitted orally, then it was in writings, which allowed us to find traces of the use of these different plants in the oldest civilizations in different parts of the world (Quetin, 2002). Algeria is no exception, and the use of plants in traditional medicine to treat various diseases has grown dramatically.

Among the toxic plants used in medicine, it is the castor oil plant, *Ricinus communis* L, which belongs to the Euphorbiaceae family Originating from the Middle East and North-East Africa, it has spread all over the world, where the climate allowed it. It is commonly called in Algeria under the name of “Kharouaa”, which is the cause of several intoxications occurring especially during the ripening period of the seeds due to the presence of highly toxic glycoproteins. On the other hand, the plant is oilseed which has allowed us to extract very important oil in various sectors.

Against this background is the present work, the main objective of which is to study the quality of the castor oil extract extracted in the laboratory and the physicochemical characterization of this oil.

2. Material and methods

2.1. Oil extraction

The seeds of *Ricinus communis* L (Photo 1) are collected in the region of Nédroma located in the north-west of the wilaya of Tlemcen, Algeria. For best oil yield, the seeds should be shelled by hand and then crushed with a mortar.

Photo 1. Seeds of *Ricinus communis* L.

This method consists of performing an extraction for 4 h. 10 g of the powder was depleted in fat by passing petroleum ether through the soxhlet device. Yield is the ratio of the mass of the oil to the mass of the plant material.

2.2. Physical parameters

2.2.1. Relative density

The principle of density is based on measuring the mass at room temperature (20°C), of a volume of oil contained in the pycnometer previously calibrated at the same temperature. The value expressed in grams per ml or in kilograms per liter (NF ISO 6883-2014).

The density is calculated by the following formula:

$$\mathbf{D20 = M2\text{-}M0 / M1\text{-}M0}$$

M0: mass of empty pycnometer; M1: mass in grams of the pycnometer filled with distilled water; M2: mass in grams of the pycnometer filled with oil.

2.2.2. Refractive index

The refractive index is the ratio of the speed of light in air at a defined wavelength to the speed of propagation in the substance (NF ISO 6320-2017). The measurements are carried out using a refractometer at a temperature of 20°C for direct measurements of the angle of refraction.

2.2.3. Rotating power

The polarimeter is a device that measures the angle of rotation of the plane of polarization of a light beam passing through an optically active substance.

2.3. Chemical parameters

2.3.1. Acid Index (IA)

The acid number of a fatty substance and the number in milligrams of potassium hydroxide necessary (KOH) necessary for the neutralization of the free fatty acids contained in a gram of fatty substance (J.O. n° 68 - 2012). This is a parameter that allows us to check the degree of deterioration of the oil. The acid number is given by the following formula (J.O. n° 68 - 2012):

$$IA(\%) = \frac{56.1 \times V \times C}{m}$$

56.1 The molar mass (g / moles) of potassium hydroxide (KOH); V: the volume in ml of KOH used; C: the exact concentration in moles per liter of the potassium hydroxide solution used.

2.3.2. Saponification index (IS)

The saponification number is the number of milligrams of potassium hydroxide - Place the flask on the heater. This index is calculated by the following formula: (J.O. n° 64 - 2011)

$$IS = \frac{(V0 - V1) \times C \times 56.1}{m}$$

56.1: the molar mass of potassium hydroxide (KOH); V0: The volume, in milliliters, of the standard hydrochloric acid solution used for the blank test; V1: The volume, in millilitres, of the standard hydrochloric acid solution used for the determination; m: The mass, in grams, of the test sample.

2.3.3. Peroxide index (IP)

The Peroxide Index is the quantity of product present in the sample, expressed in milliequivalent of active oxygen per kilogram, oxidizing potassium iodine under the operating conditions described (J.O. n° 64 - 2011). The peroxide number expressed in milliequivalents active oxygen per kilogram of oil and calculated by the following formula:

$$IP = \frac{T(V1 - V0)}{m} \times 100$$

V0: The volume, in milliliters, of the sodium thiosulfate solution used for the blank test; V1: The volume, in milliliters, of the sodium thiosulfate solution, used for the determination; T: The normality of the sodium thiosulfate solution used; m: The mass, in grams, of the test sample.

2.3.4. Iodine index (II)

The iodine number is the mass in grams of iodine attached to the double bonds present in 100 g of fatty substances. It is for the determination of the unsaturation of oils. The iodine number is calculated by the following formula (NF ISO 3961-2013):

$$II = (12.69C\ (V1-V2))\ /\ M$$

C: The concentration, exact in mole / l of the sodium thiosulfate solution Na2S2O3 used; V1: The volume, one milliliter, of the $Na_2S_2O_3$ thiosulfate solution used for the blank test; V2: The volume, one milliliter, of the $Na_2S_2O_3$ thiosulfate solution used for the determination; N: The mass, in grams of the test sample.

2.4. Study of antioxidant activity by DPPH

At different concentrations, 50 µL of each oil was added to 1950 µL of a methanolic solution of 2,2-diphenyl-1-picrylhydrazyl (DPPH•) at 6.34 10-5 M. For each concentration, a blank was prepared. A negative control was prepared, in parallel, while mixing 50 µL of methanol with 1950 µL of a methanolic solution of DPPH° at the same used concentration. After incubation in the dark for 30 minutes and at room temperature, the reduction in DPPH° was accompanied by a change of color from purple to yellow in the solution. The absorbances were read at 515 nm using a spectrophotometer. The radical scavenging activity was calculated as a percentage of DPPH° discoloration using the equation:

DPPH° radical scavenging (%) = [(A0 – A1 /A0] x 100

Where A0 and A1 are the absorbance at 30 min of the positive control and the oil, respectively. The anti-radical activity was expressed as IC_{50} (µg/mL), this was the extract concentration required to cause a reduction of 50% to absorbance at 517 nm. A lower IC_{50} value corresponds to the oil effectiveness (Chaouche et al. 2015).

3. Results and discussion

3.1. Extraction yield of castor oil

The extraction of castor oil from the seeds of *Ricinus communis* L, by the soxhlet method, using petroleum ether as an apolar organic solvent, which allowed us to obtain a colored extract pale yellow more or less thick, obtained after 4 hour of extraction with an extraction yield of 29.17%. This yield is close to that obtained by Guergour, (2011) which is 30%.

3.2. Physico-chemical analysis of castor oil

The results obtained from the physico-chemical analyzes are shown in the following Table 1.

Table 1. Physico-chemical parameters of castor oil.

Physico-chemical parameters	Values
Density at 20°C	0.956
Refractive index at 20°C	1.4778
Rotation Angle	4.20
Iodine index (g / 100 g of oil)	93.39
Saponification index (mg de KOH /g of Oil)	177.42
Peroxide index (meqO_2/kg of Oil)	7.83
Acid index(mg KOH/g of Oil)	0.57
Acidity in% by mass	0.28

3.3. Physical analyzes

3.3.1. Relative density

Determining the relative density of oil tells us about its purity, which indicates the presence of foreign bodies; it is a function of the chemical composition of the oils and of the temperature (Karleskind, 1992). Castor oil has a specific gravity (0.956) similar to that given by the Codex Alimentarius approximately (0.958). This density value of castor oil found in our study is high due to its high viscosity. The denser the oil, the more viscous it is. This explains its viscous appearance compared to other oils.

3.3.2. Refractive index

The refractive index is an important quality parameter and also represents a criterion of the purity of the oil. It depends on the chemical composition of the oils and the temperature.

In general, the refractive index increases with unsaturation or the presence of a foreign product (Karleskind, 1992). The value of the refractive index found in our study is 1.4778, this value meets the standard given by the Codex Alimentarius, which is approximately 1.479.

3.3.3. Rotary power

Rotary power is a physical parameter, allowing us to measure the angle of rotation of the plane of polarization, and to learn about the nature of the molecule.

In our study on castor oil, the polarimeter allows us to obtain several approximate values of the angle of deflection of polarized light up to a stable value of 4.20 it is a value which responds to the standard given by the Codex Alimentarius which is in an interval of 3.5 to 6.0.

3.4. Chemical analyzes

3.4.1. Acid index

The acid number of a fatty substance characterizes the purity and stability of oils, is a good way to determine its deterioration by hydrolysis (Gossa and Mekchiche, 2014). Our castor oil has an acid number of (0.57mg KOH/g) which is lower than the value of 1.5 maximum value given by the Codex Alimentarius. The free acidity which is with a value of 0.28% can be calculated from the results obtained for the determination of the acid number.

3.4.2. Saponification index

The saponification index is related to the length of the fatty acid chains that make up the oil, it allows characterizing the molecular weight and the average length of the fatty chains to which it is inversely proportional. (Harper, 1977). The value of the saponification index found in this study is of the order of 177.42 (Mg KOH/g oil), is a value that meets the codex standard which is in the range of 177 to 187 mg KOH/g oil.

3.4.3. Peroxide index

The value of the peroxide number allows us to assess the oxidation state of the oil. The peroxide number is linked to storage conditions and extraction methods. The chemical deterioration of oils is caused by the oxidation of the air which results in the formation of peroxides (Codex Alimentarius, 1992). The value of the peroxide number found in this study is of the order of 7.83 milliequivalent of active O_2/Kg, relatively average value given that the solvent extraction was carried out hot (possible thermo-oxidation reaction with formation of peroxides), it is less than 10 meq active O_2/Kg, which characterizes most conventional oils.

3.4.4. Iodine index

The iodine value gives an overall indication of the unsaturation of the oil (Presence of unsaturated fatty acids). The value of 93.39 g/100g of iodine value oil found in our study on castor oil shows that it is close to the standard established by the Codex Alimentarius which set them between 82 and 90 g / 100g of oil.

3.5. Antioxidant activity

The study of the antioxidant activity of castor oil is done by the DPPH radical scavenging technique, *in vitro*, in order to measure the IC_{50} values. The results for the oil are expressed as % inhibition, and shown in Table 2.

Table 2. Rate of DPPH inhibition by castor oil.

Concentration µg/ml	% Inhibition
956	94.34
478	40.63
318	26.89
239	21.81

The antioxidant activity of castor oil is expressed in IC_{50}. This IC_{50} is determined from the table, it is 431.73 µg/ml for this oil.

4. Conclusion

The present work consists in extracting the oil of *Ricinus communis* L called castor oil plant and constitutes a contribution to a better knowledge of the oil in order to promote its development from the physicochemical properties, as well as the antioxidant activity. The oil extraction yield by the Soxhlet method, using petroleum ether as the non-polar organic solvent, is of the order of 29.17%, this value is close to some previous work. The physico-chemical analyzes carried out in our study are (density, refractive index, rotatory power, acid index, acidity, peroxide index, saponification index and l iodine index). These parameters gave results in accordance with the standards established by the Codex Alimentarius. In addition, the result of the evaluation of antioxidant activity reveals that this oil has less antioxidant power, compared to the antioxidant of other vegetable oils. The work carried out represents an initiation into the search for natural oils of biological interest and with a wide field of use.

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